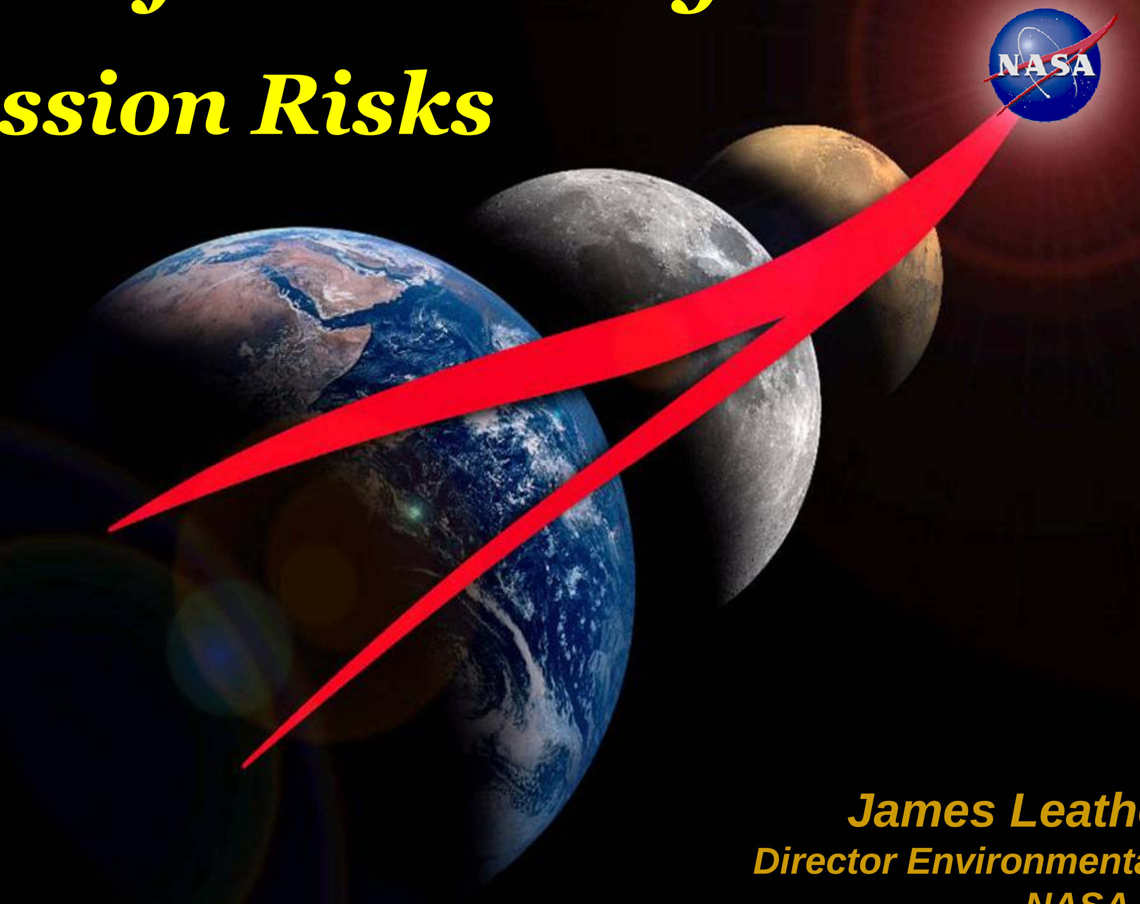
Environmental Assurance - Framework for Reducing NASA Mission Risks



James Leatherwood

Director Environmental Management

NASA

Nov 2008

Sustainability

"THE HUMAN COMMUNITY AND THE NATURAL WORLD WILL GO INTO THE FUTURE AS A SINGLE SACRED COMMUNITY OR WE WILL BOTH PERISH IN THE DESERT"

- Thomas Berry

Outline

- Background
- Environmental Assurance – Context
- Environmental Assurance – Alignment with Mission
- Current Actions
- Summary
- Contacts and Resources

Background

Sustainability enables NASA to meet its Mission

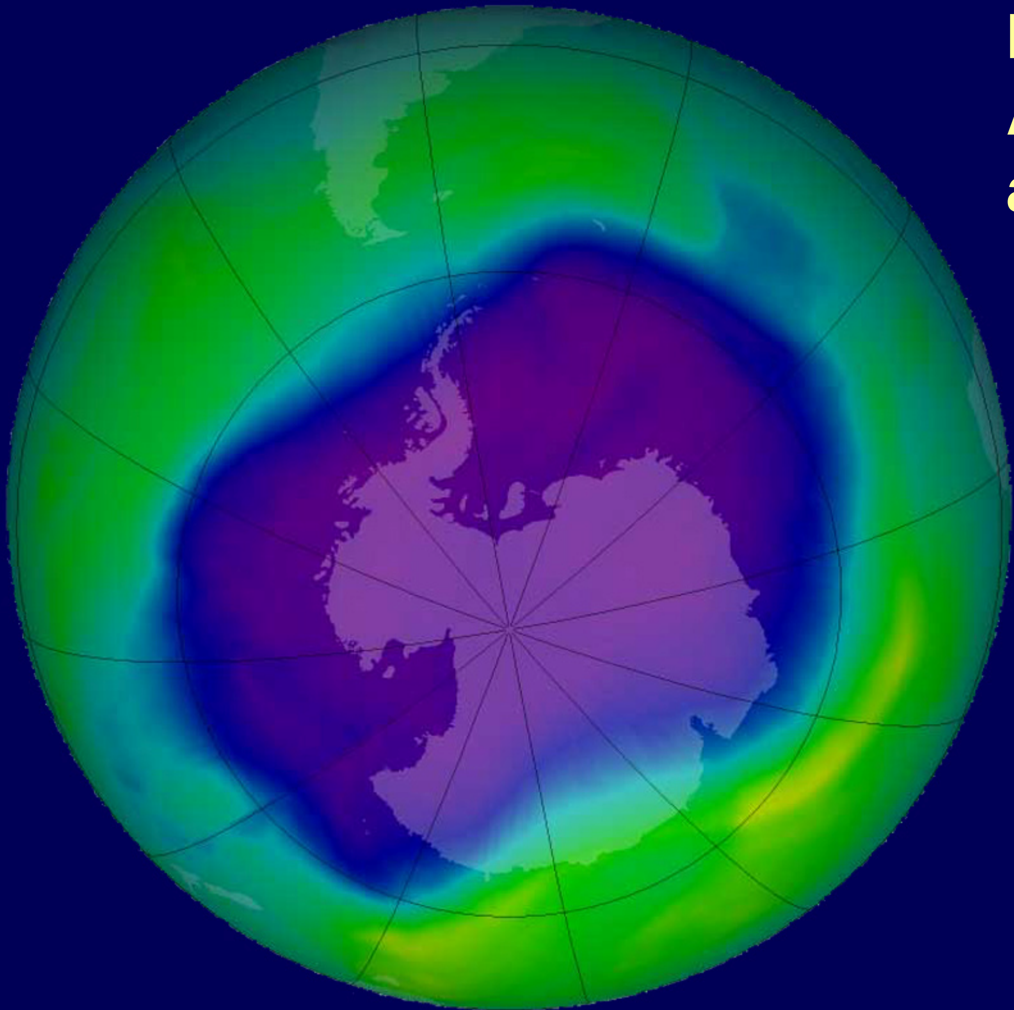
- Before communities were recycling and businesses were turning “green,” NASA was implementing sustainability practices to support human life in space.
- NASA was established in 1958 to explore space.
- Space is an unforgiving environment without air to breath, usable water to survive, or fossil fuel to power such exploration.
- Space Exploration demand effective sustainability practices.

System Requirements

- **Earth – natural life support system.**
- **Space – engineered advanced life-support systems.**
- **Life support systems – full ecological system integration.**

Compliance
'End of Pipe'

Ozone Hole Discovered in 1985



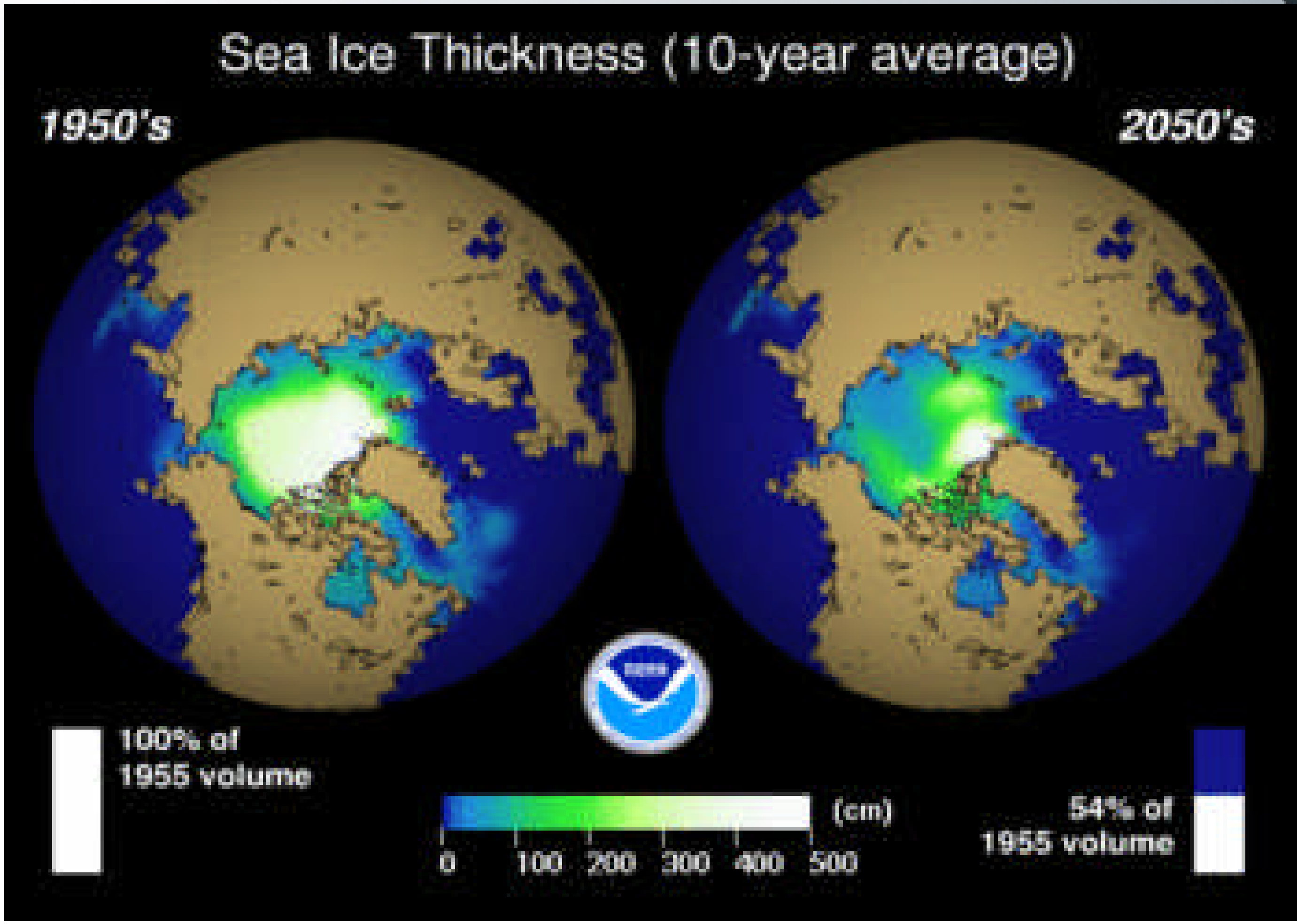
NASA and NOAA Announce Ozone Hole is a Double Record Breaker

October 19, 2006

From September 21-30, 2006 the average area of the ozone hole was the largest ever observed, at 10.6 million square miles. This image, from Sept. 24, the Antarctic ozone hole was equal to the record single-day largest area of 11.4 million square miles, reached on Sept. 9, 2000. The blue and purple colors are where there is the least ozone, and the greens, yellows, and reds are where there is more ozone.

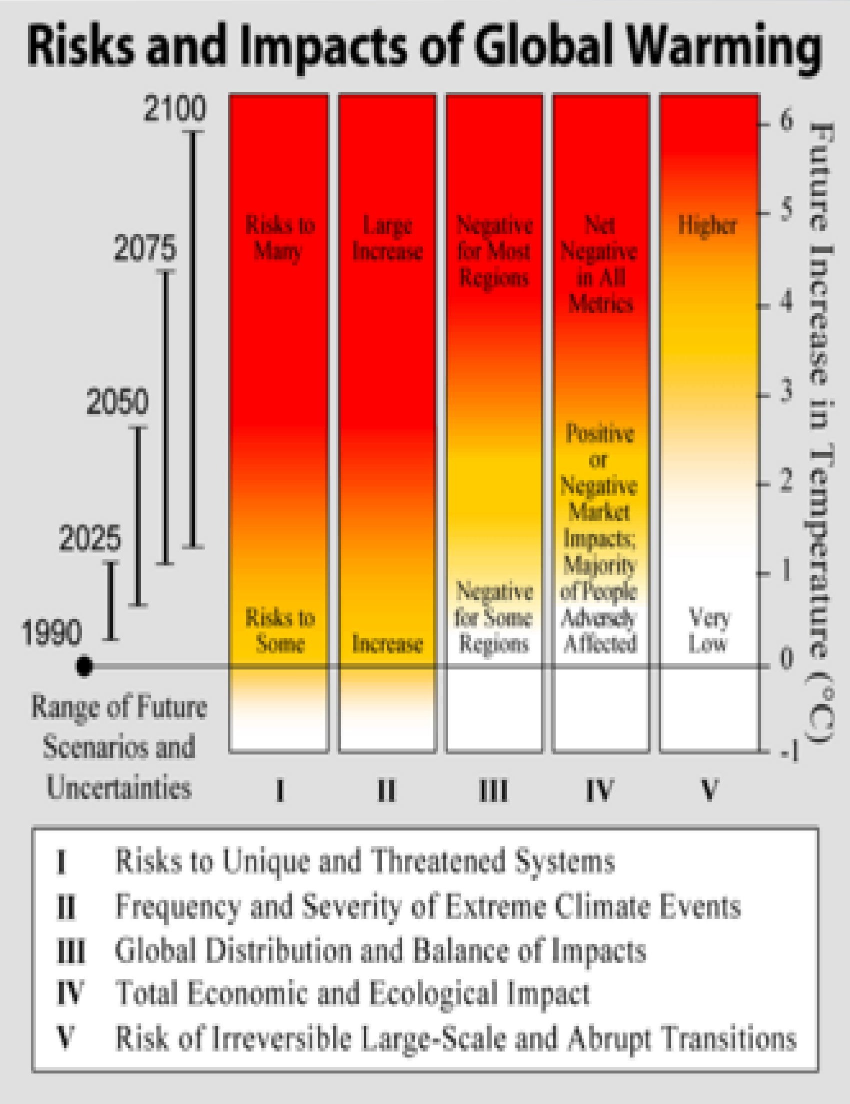
http://www.nasa.gov/vision/earth/lookingatearth/ozone_record.html

Green House Gas Emissions



Geophysical Fluid Dynamics Laboratory (GFDL)
www.globalwarmingart.com

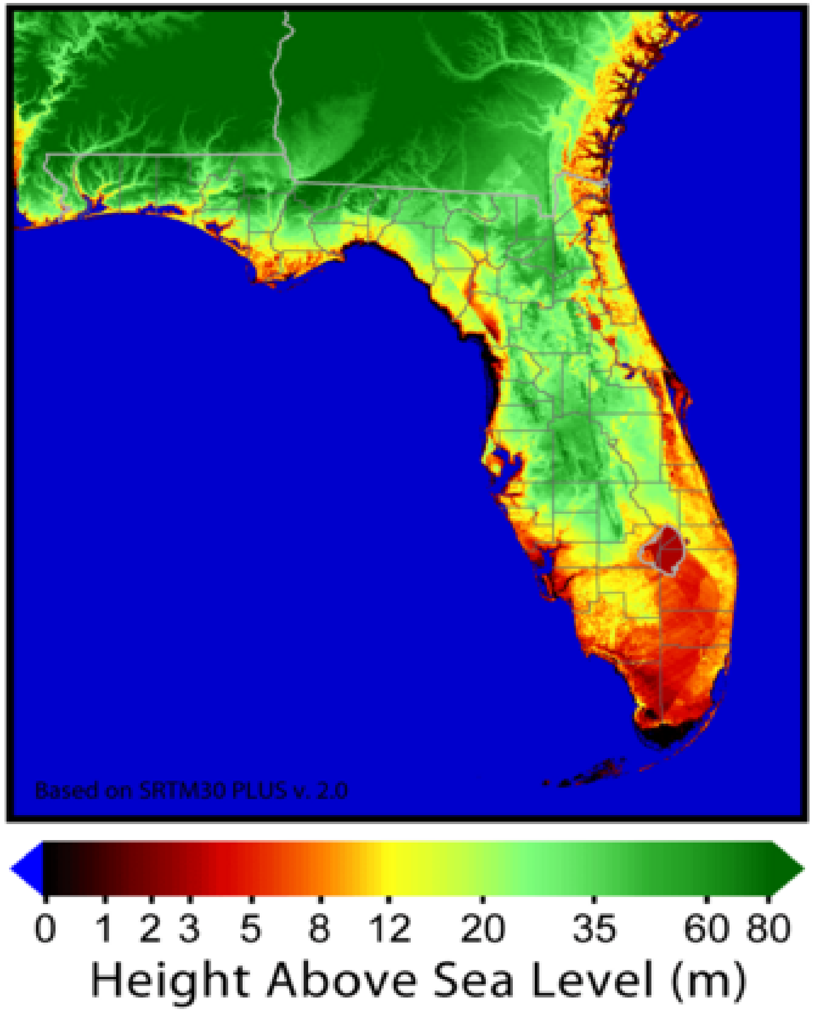
Green House Gas Emissions



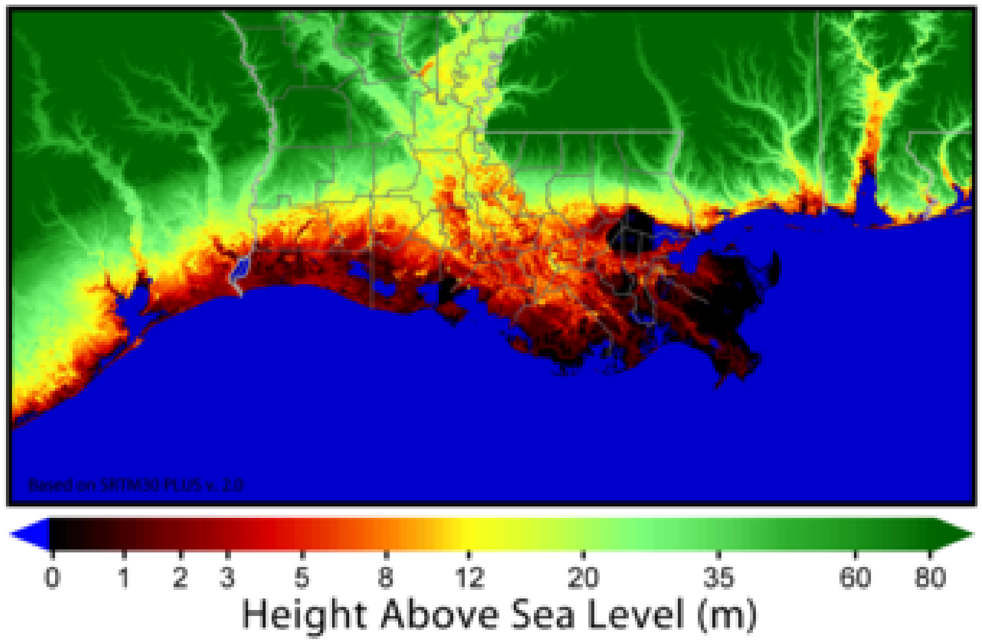
Intergovernmental Panel on Climate Change (**IPCC**)
www.globalwarmingart.com

Green House Gas Emissions

Sea Level Risks - Florida



Sea Level Risks - Louisiana

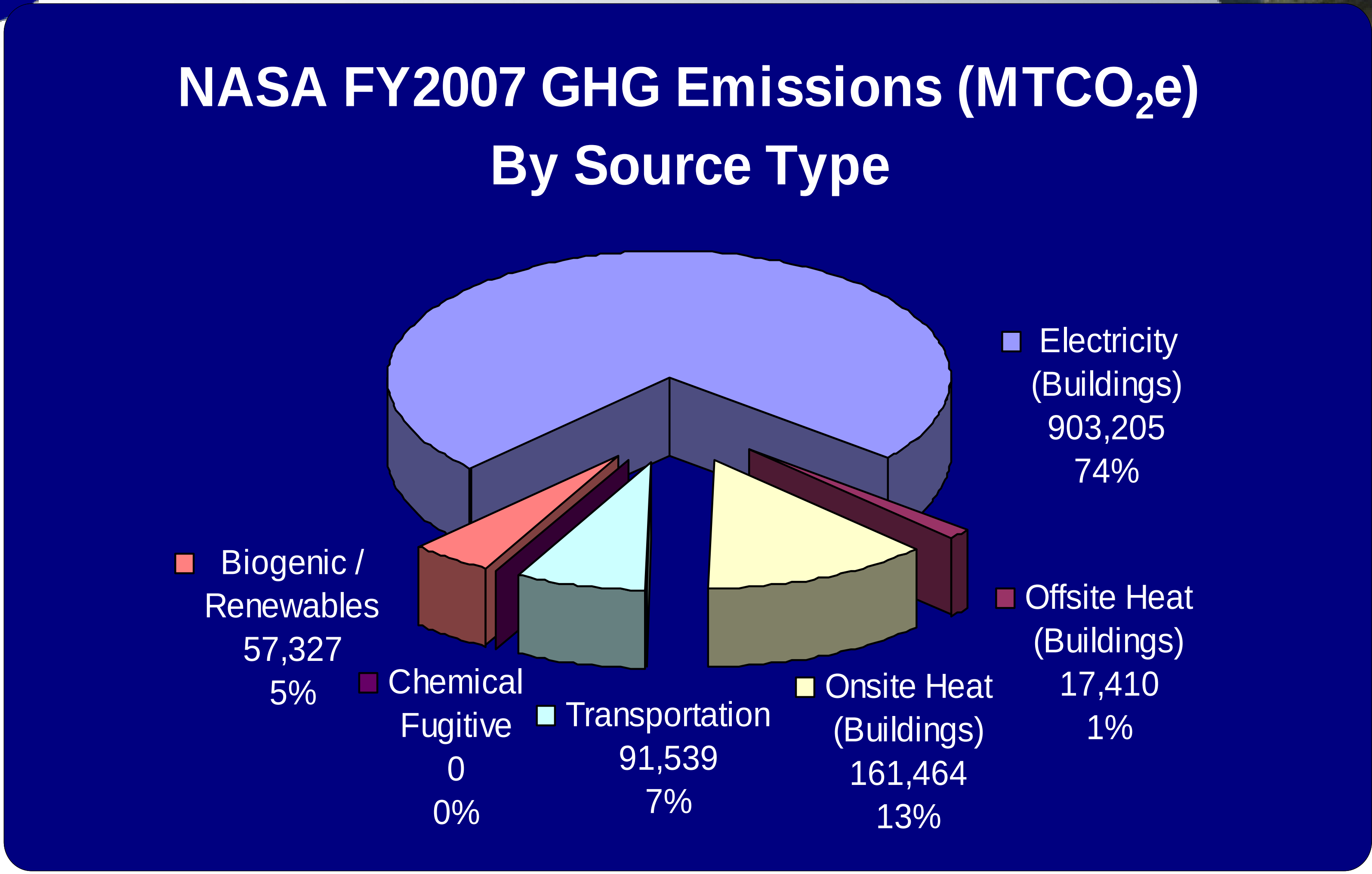


www.globalwarmingart.com

NASA-KSC Challenges:

Photographs Courtesy of J. Shaffer (2008)

Green House Gas Emissions



MATERIALS MANAGEMENT

REMOTE SITE RESEARCH: *"THE REALITY"*

www.cep.aq/default. asp?casid=6896

http://web.archive.org/web/20051125095443/
www.antarctica.ac.uk/About_BAS/Cambridge
/Divisions/EID/Environment/fb_before.jpg

http://response.restoration.noaa.gov/pribilof/

AEROSPACE BONE-YARD

Address http://www.airfields-freeman.com/CA/ElMirage_CA_boneyard_03.jpg

Can NASA afford this?

Nucor -- http://www.nucor.com/indexstory.aspx?story=16

<u>Lunar and Martian Research Bases: "Sustainment" –</u>

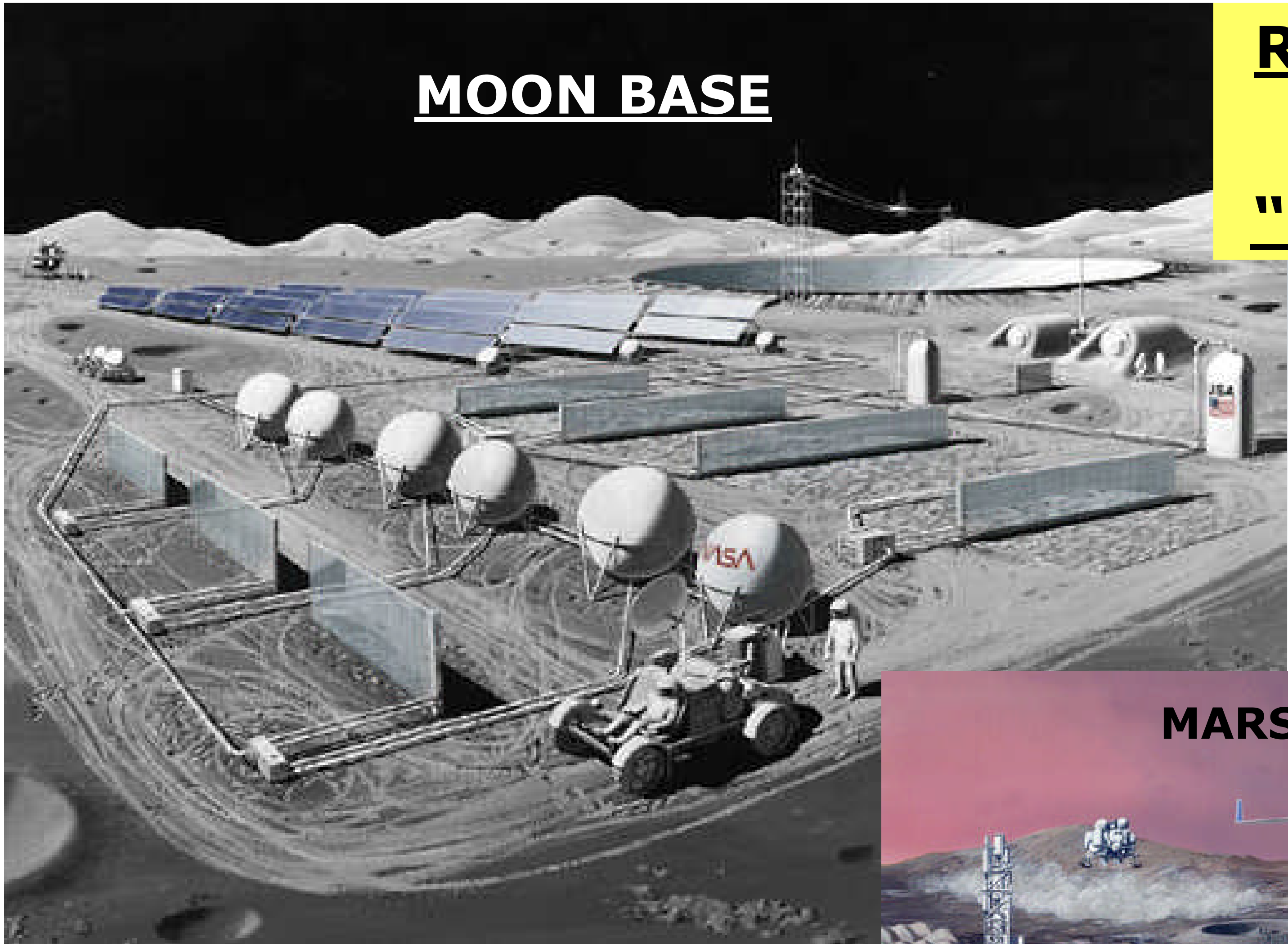
<u>AT WHAT COST TO TAXPAYERS?*</u>

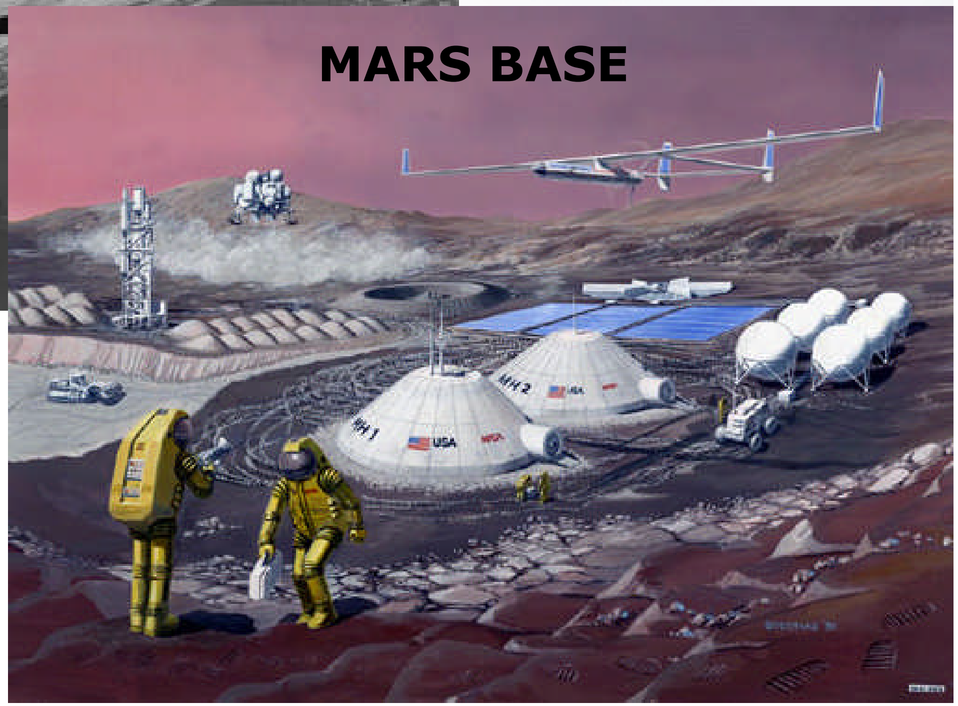
1) **$8,300** **(Titan IVB)** **to $8,500** **(space shuttle)** **per pound to LEO** **(in 2000 dollars)**
2) **$35,000 per pound to Saturn** **(Cassini probe)**

* H E McCurdy (2001) "Faster Better Cheaper: Low-Cost Innovation in the U.S. Space Progam"

REMOTE SITE RESEARCH:

"THE DREAM"



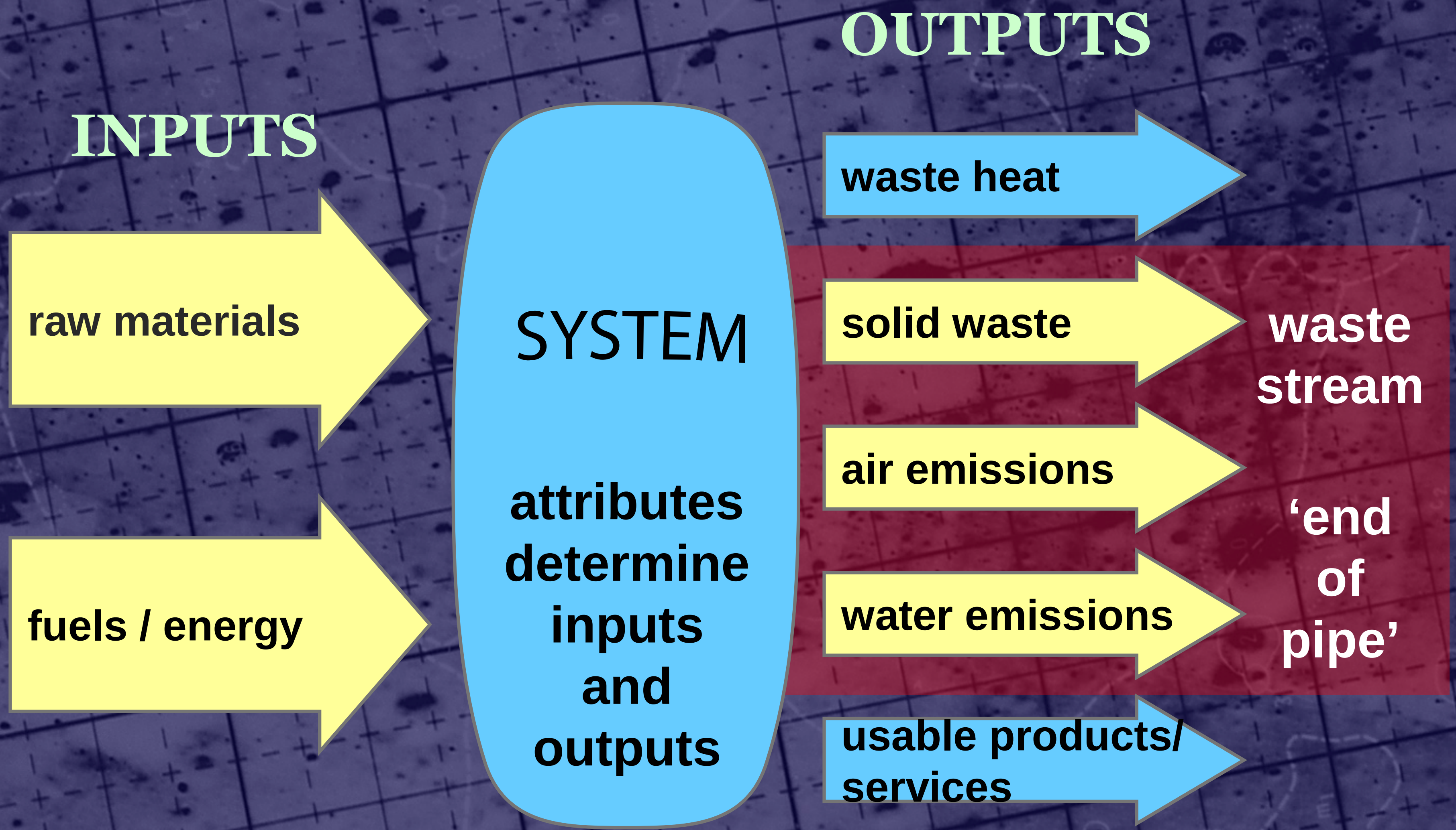


http://www.nasa.gov/centers/glenn/images/content/101885main_C91_08781_516x387.jpg

http://www.nasa.gov/centers/glenn/images/content/101903main_C88_11517_516x387.jpg

Environmental Assurance – Systems Context

System Inputs & Outputs Model



Risk Drivers

Government Requirements
- EHS-related statutes, regulations, executive orders, or policies that set requirements

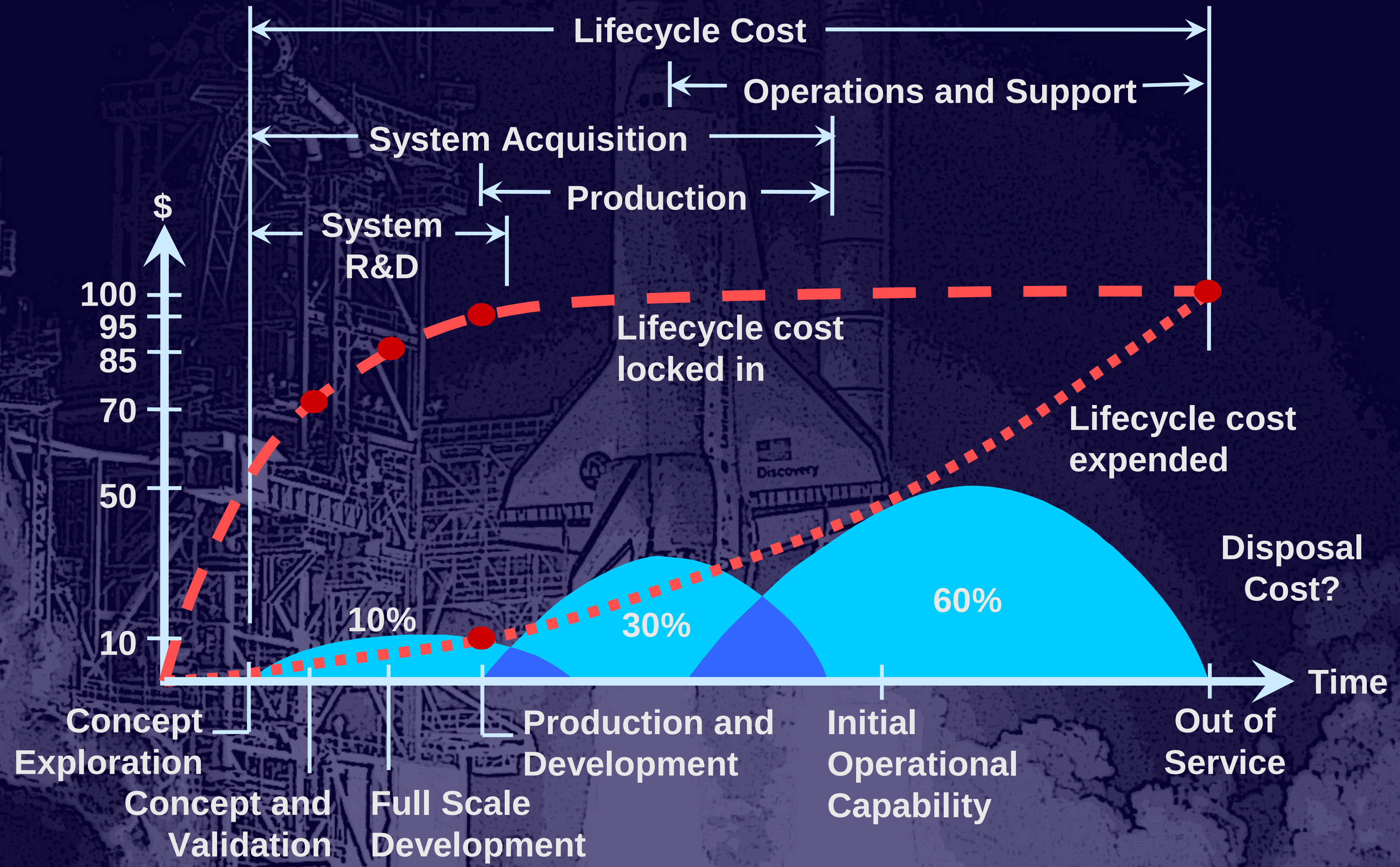
Other Environment, Health, and Safety Considerations
- Considerations related to environment, health or safety
- Often, but not always, related to "government requirements"

Vendor Economics & Issues
- Vendor decisions to change formulations, cease production of a material, or otherwise impact materials and processes
- Often related to the other drivers

Technology and Market-Based Forces
- Technology advances can reduce manufacturers' incentives to produce technologically obsolete materials
- Global trends in materials selection and procurement can impact materials availability by reducing production viability of certain low-volume items

Natural Disasters
- Manufacturing facilities and infrastructure damage by earthquake, hurricane, fire and other disasters can affect manufacturers' ability or willingness to produce materials

Impacts of Design Decisions

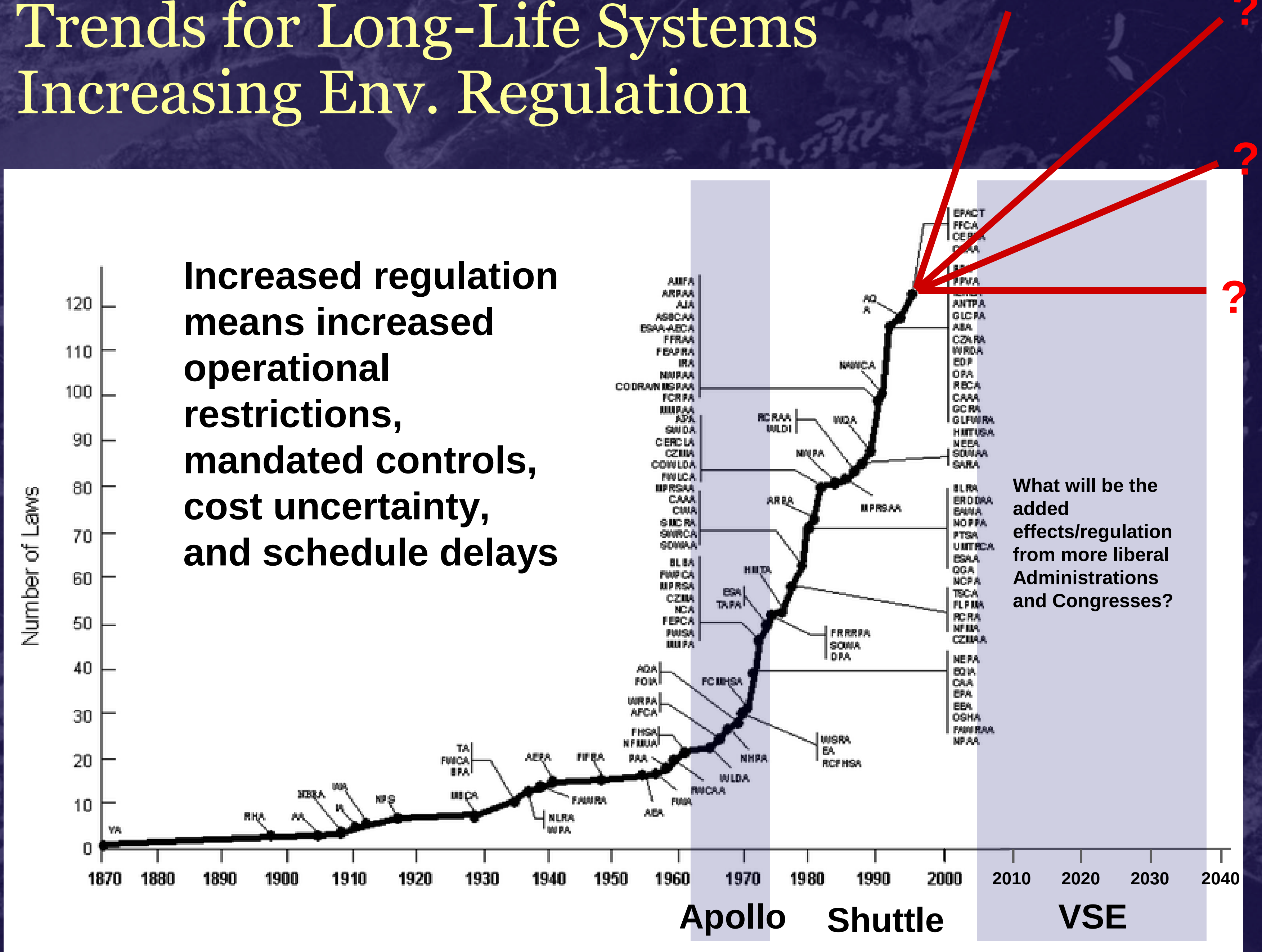


From W. J. Larson & L. K. Pranke (1999) Human Spaceflight: Mission Analysis and Design

Managing to External Requirements

- Agency Regulations
- Archaeological Resources Protection Act
- Biobased Product Procurement Requirements
- Clean Air Act (CAA)
- Clean Water Act (CWA)
- Safe Drinking Water Act
- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
- Costal Zone Management Act
- Emergency Planning and Community Right-to-Know Act (EPCRA)
- Endangered Species Act (ESA)
- Energy Policy Act of 2005
- Executive Order 11988 - Floodplain Management
- Executive Order 11990 - Protection of Wetlands
- Executive Order 12114 - Environmental Effects Abroad of Major Federal Actions
- Executive Order 12898 - Environmental Justice
- Executive Order 13148 - Greening the Government
- Executive Order 13287 - Preserve America
- Fish and Wildlife Coordination Act
- Global Climate Protection Act
- Green Computer (EPEAT) Procurement Requirements
- ISO14001 - Environmental Management Standard
- Landfill Disposal Standards
- Local Regulations
- Marine Mammal Protection Act
- Migratory Bird Treaty Act
- National Environmental Policy Act (NEPA)
- National Historic Preservation Act
- Occupational Safety and Health Act (OSHA)
- Pollution Prevention Act (PPA)
- Resource Conservation and Recovery Act (RCRA)
- State Regulations
- Superfund Amendments and Reauthorization Act (SARA)
- Toxic Substances Control Act (TSCA)

Trends for Long-Life Systems Increasing Env. Regulation

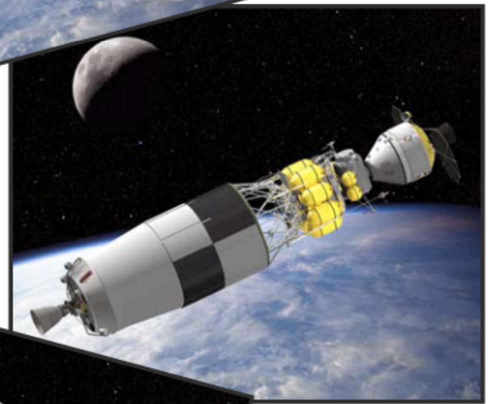


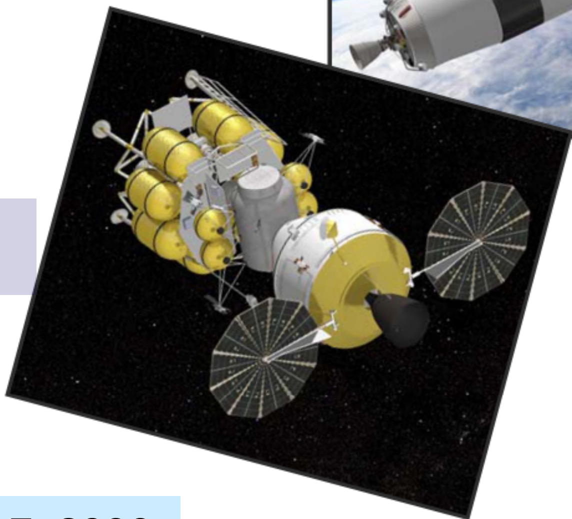
Source: J. A. Cusumano, New Technology for the Environment, Chemtech, 1992, 22(8), 482–489

Environmental Assurance - Alignment with Mission

Design Philosophy for Mission Success

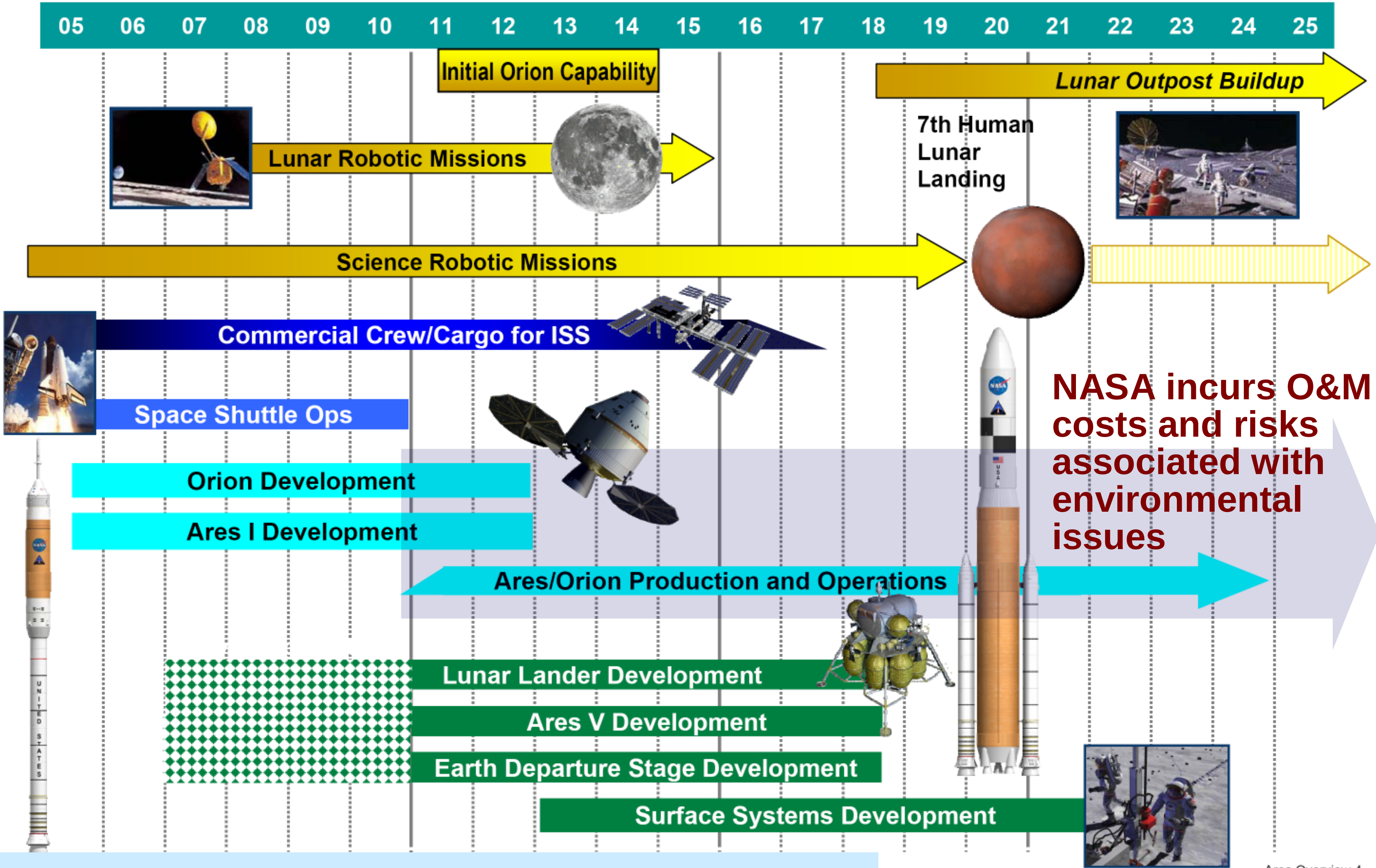
- **Keep it simple.**
  - Minimize complexity and interactions.
  - Simplify interfaces.
  - Make it robust.
- **Focus on reliability, maintainability and supportability early to improve safety and reduce operations costs.**
- **Apply validated engineering tools, models, and data to new vehicle configurations.**
- **Apply Lessons Learned**





Adapted from Ares 1 SRR Presentation, Nov 6-7, 2006

NASA's Exploration Roadmap



Adapted from Ares 1 SRR Presentation, Nov 6-7, 2006

Environmental Assurance Focus

~~Risks posed by the Program to the environment~~

- ~~Identified under NEPA through the Environmental Impact Statement (EIS) process prior to Program inception~~
- ~~The EIS describes programmatic options and addresses environmental considerations associated with each~~

Risks posed to the Program by environmentally-related drivers

- Real-time risks from a new environmental driver
- Real-time risks from configuration issues/changes that trigger an existing driver

Environmental Assurance Definition

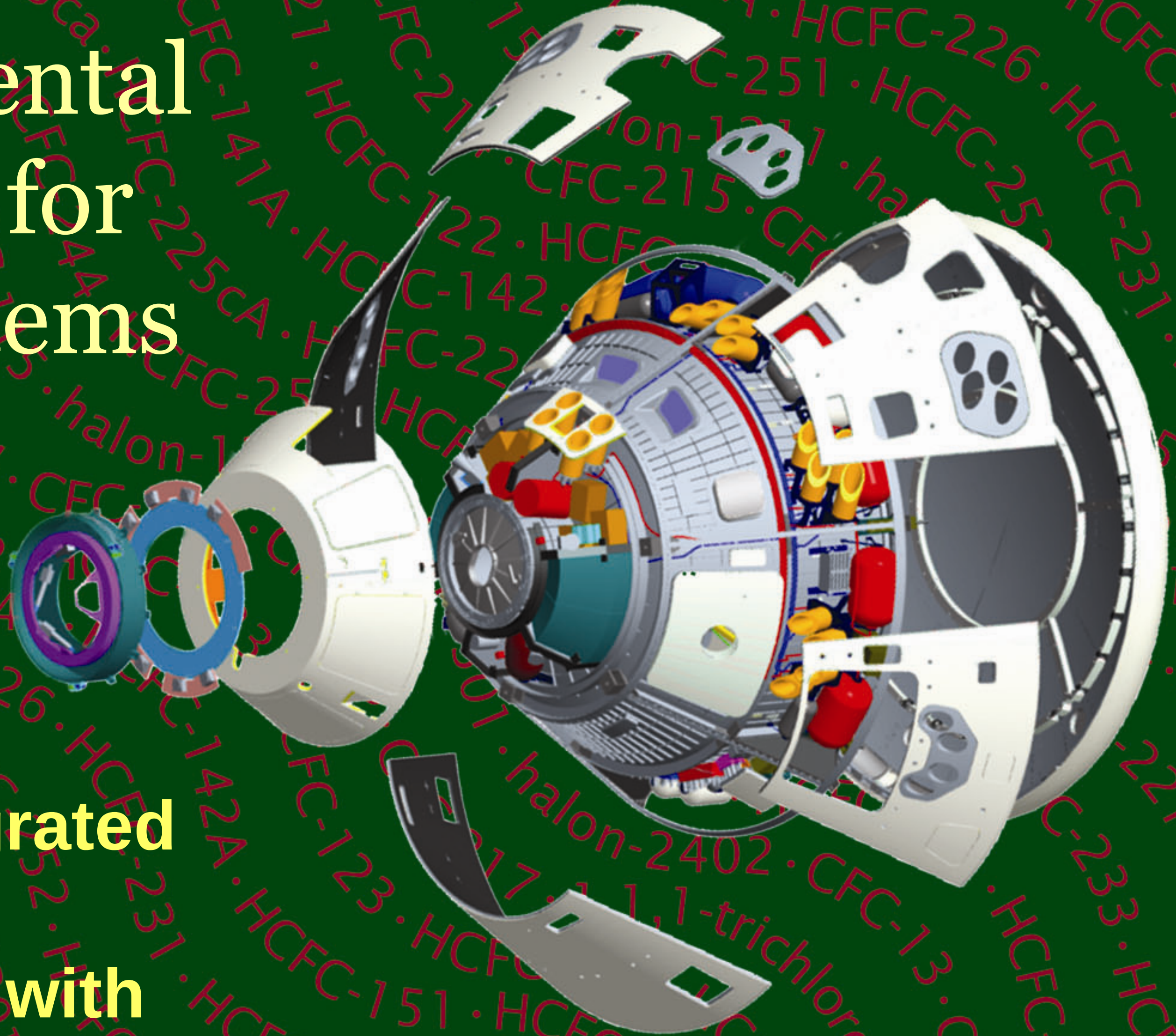
Environmental Assurance is the proactive detection, analysis, mitigation, and communication of environmentally driven risks to NASA mission-required research, development, fabrication, processing and operations.

Environmental Assurance Goals

1. **Identify, analyze, and measure environmentally driven programmatic and institutional risks.**
2. **Communicate environmentally driven programmatic and institutional risks to appropriate owners (when possible, in early phases of program and project planning and execution)**
3. **Team/partner with risk owners to proactively reduce risk's impact, likelihood, and scope (e.g., may apply to multiple programs and projects)**
   - Work with regulatory authorities
   - Acquire special waivers, if possible, from regulating organization
   - Identify and validate appropriate solutions for mitigation of environmentally driven risks. As needed, adapt high-TRL technology and/or increase TRL for new technology for NASA's use.

The risk owners (e.g., programs and projects) will have day-to-day responsibility for management of their risks.

Environmental Assurance for NASA Systems



Bridges Integrated Mission Risk Management with Sustainability

Current Actions

Key Actions

- Encroachment Analysis/Env Services
- Renewable Energy Assessment
- Water Conservation Assessment
- Environmental Risk Functional Reviews
- Sustainable Material Management
- GHG Accounting/Climate Change Risk Mgt
- NEPA Regulation Update
- Green Engineering
- Social Responsibility Efforts
- Cleanup/Environmental Liabilities
- National/International Env Policy Support

Summary

Summary

- We have leveraged and refocused environmental capabilities at Centers and Headquarters to develop Environmental Assurance in support of mission
- Environmental Assurance practiced at NASA will work to proactively identify, communicate, and mitigate risks to mission in a changing regulatory and resource-constrained climate to maximize options for programs and projects.


FALLING
ROCK

Contacts and Resources

Contacts and Resources

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paul.robert-1@nasa.gov

Websites

Environmental Management Division
http://oim.hq.nasa.gov/oia/emd/index.html

Technology Evaluation for Environmental Risk Mitigation
http://acqp2.nasa.gov/

FedCenter (Government Environmental Portal)
http://www.fedcenter.gov/

Clean Joint Group on Pollution Prevention
http://www.jgpp.com/index.html

The Twelve Principles of Green Engineering

1. **Inherent Rather Than Circumstantial.** Designers need to strive to ensure that all materials and energy inputs and outputs are as inherently nonhazardous as possible.
2. **Prevention Instead of Treatment.** It is better to prevent waste than to treat or clean up waste after it is formed.
3. **Design for Separation.** Separation and purification operations should be designed to minimize energy consumption and materials use.
4. **Maximize Efficiency.** Products, processes, and systems should be designed to maximize mass, energy, space, and time efficiency.
5. **Output-Pulled Versus Input-Pushed.** Products, processes, and systems should be "output pulled" rather than "input pushed" through the use of energy and materials.
6. **Conserve Complexity.** Embedded entropy and complexity must be viewed as an investment when making design choices on recycle, reuse, or beneficial disposition.
7. **Durability Rather Than Immortality.** Targeted durability, not immortality, should be a design goal.
8. **Meet Need, Minimize Excess.** Design for unnecessary capacity or capability (e.g., "one size fits all") solutions should be considered a design flaw.
9. **Minimize Material Diversity.** Material diversity in multicomponent products should be minimized to promote disassembly and value retention.
10. **Integrate Material and Energy Flows.** Design of products, processes, and systems must include integration and interconnectivity with available energy and materials flows.
11. **Design for Commercial "Afterlife".** Products, processes, and systems should be designed for performance in a commercial "afterlife."
12. **Renewable Rather Than Depleting.** Material and energy inputs should be renewable rather than depleting.

* Anastas, P.T., and Zimmerman, J.B., "Design through the Twelve Principles of Green Engineering", Env. Sci. and Tech., 37, 5, 95 ? 101, 2003.

Questions?